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# Control of Rhizome Johnsongrass (*Sorghum halepense*) in Sugarcane with Trifloxysulfuron and Asulam

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It has been suggested that trifloxysulfuron might increase the efficacy of asulam for control of johnsongrass. Container and field studies were conducted to determine the efficacy of POST applications of trifloxysulfuron and asulam for johnsongrass control in sugarcane. Asulam was applied at 460 and 920 g ai/ha to container-grown johnsongrass plants, with and without 8 g ai/ha of trifloxysulfuron. Combinations of asulam and trifloxysulfuron generally reduced johnsongrass height, rhizome length, and biomass more than when either was applied alone. Results suggested that combinations of asulam and trifloxysulfuron were synergistic in their control of johnsongrass biomass 8 wk after treatment. In a sugarcane field heavily infested with rhizome johnsongrass, asulam was applied at 1,800, 2,800, and 3,700 g/ha with and without trifloxysulfuron at 16 g/ha. Asulam plus trifloxysulfuron generally controlled johnsongrass more effectively than either herbicide alone. The control of johnsongrass with asulam at 1,800 g/ha resulted in an increase in sugar yield of more than twice that in the nontreated control. Sugar yield increased further when asulam was applied at 2,800 g/ha or combined with trifloxysulfuron, but application of trifloxysulfuron alone did not increase yield. Combinations of asulam and trifloxysulfuron might slow the spread of rhizome johnsongrass enough to allow an increased number of ratoon crops before sugarcane fields need to be replanted.

**Nomenclature:** Asulam; trifloxysulfuron; johnsongrass, *Sorghum halepense* L. Pers. SORHA; sugarcane, *Saccharum* interspecific hybrid 'LCP 85-384'.

**Key words:** Herbicide, perennial weed control, synergism, weed interference.

In Louisiana, sugarcane is cultivated as a vegetatively propagated perennial crop grown on raised beds with three to five annual harvests from each planting. Raised beds are typically undisturbed during the crop cycle, allowing perennial weeds, such as johnsongrass, to become established. Johnsongrass is one of the most serious weed problems for sugarcane production in the United States and was ranked as the most widespread and economically important weed in Louisiana sugarcane (Anonymous 1983). Johnsongrass interference can reduce sugarcane yield by as much as 54% and can reduce the number of crops harvested from a planting of sugarcane (Richard 1990).

Seedling johnsongrass can be selectively controlled in sugarcane with PRE herbicides, but these herbicides have little or no effect on rhizome johnsongrass (Anonymous 2008; Millhollon 1993; Richard and Griffin 1993). Asulam, a carbamate herbicide, may be applied for POST control of rhizome johnsongrass in sugarcane (Anonymous 2008; Millhollon 1976; Richard and Griffin 1993). Asulam inhibits dihydropteroate (DHP) synthase, an enzyme in folic acid biosynthesis, resulting in inhibition of protein and nucleic acid synthesis (Stephen et al. 1980; Veerasekaran et al. 1981a,b). Asulam has also been reported to suppress smallflowered alexandergrass [*Urochloa subquadripara* (Trin.) R.D. Webster] and itchgrass [*Rottboellia cochinchinensis* (Lour.) W.D. Clayton], with little or no injury to sugarcane (Lencse et al. 1992; Millhollon 1976; Richard 1990; Teuton et al. 2004). Asulam fails to completely control rhizome johnsongrass. Asulam also requires an extended rain-free period for maximum control (Bruff et al. 1995; Richard 1986). Failure to control johnsongrass results in higher infestation levels in subsequent ratoon crops, warranting the premature destruction of the crop to rehabilitate fields.

The herbicide trifloxysulfuron was recently registered for use in sugarcane and has been reported to control seedling johnsongrass and suppress rhizome johnsongrass (Rawls et al. 2000; Richard 2000; Singh and Singh 2004). It also effectively controls various broadleaf weeds, both PRE and POST, including annual morningglory (*Ipomea* spp.) (Singh and Singh 2004; Brecke and Stephenson 2006; Grichar and Minton 2007; Portefield et al. 2002; Richardson et al. 2004). Trifloxysulfuron is a sulfonylurea herbicide and inhibits acetolactate synthase (ALS), an enzyme involved in the production of three essential branched-chain amino acids (LaRossa and Schloss 1984; Ray 1984). Jones et al. (2002) showed that trifloxysulfuron applied at 16 g/ha with asulam at 1,900 g/ha controlled johnsongrass similarly to asulam alone at 3,700 g/ha. The objective of this study was to determine the efficacy of trifloxysulfuron and asulam applied separately and in combination for control of johnsongrass in sugarcane.

## Materials and Methods

Asulam[1] and trifloxysulfuron[2] were applied POST to rhizome johnsongrass plants in containers and in sugarcane field studies at the Sugarcane Research Laboratory in Houma, LA, in 2005 and 2006.

**Container Study.** Johnsongrass seeds were planted in a rectangular flat container measuring 30 cm long, 45 cm wide and 8 cm deep filled with potting mix[3] in February 2005. On reaching the two-leaf stage, seedlings were transplanted into 2-L containers of 15 cm diam and filled with sterilized field soil (Cancienne silty loam; fine-silty, mixed, superactive, nonacid,

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hyperthermic Fluvaquentic Epiaquepts). Seedlings were grown in the greenhouse with supplemental lighting from metal halide lights to provide a 12-hr photoperiod. Plants were fertilized weekly with 20–20–20 N–P–K fertilizer and watered daily. On reaching approximately 50 cm in height, plants were clipped to approximately 10 cm above the soil surface to promote tillering and to allow for the development of rhizomes. One week after clipping, plants were moved outdoors to allow growth under natural conditions. Plants continued to be watered daily and fertilized weekly.

Herbicides were applied on April 12, 2005, to one set of plants measuring 53 cm to the uppermost leaf collar and on April 18, 2005, to a duplicate set measuring 74 cm. Treatments were trifloxysulfuron at 8 g/ha, asulam at 460 and 920 g/ha, trifloxysulfuron plus asulam at 8 plus 460 and 8 plus 920 g/ha, and a nontreated control. All herbicide treatments were applied with a non-ionic surfactant[4] at 0.25% (v/v). Care was taken during daily watering to prevent wetting foliage for the first week after treatment (WAT). Asulam and trifloxysulfuron rates were less than those recommended for field applications. Potted plants are typically more susceptible to herbicide injury, and an objective of this experiment was to measure a rate effect for asulam.

Herbicides were applied with a tractor-mounted sprayer equipped with 8002 flat fan nozzles[5] at a volume of 187 L/ha with the use of compressed air (221 kPa) as the propellant. Following application, containers were arranged in a randomized complete block with four replications. Two containers per replication were used for each treatment to allow for destructive measurements of biomass and rhizome length at 4 and 8 WAT.

Johnsongrass height was measured from the soil surface to the uppermost leaf collar of the longest stem in each container. Measurements were taken at 2, 4, and 8 WAT. The biomass of shoots, roots, and rhizomes and the number and length of rhizomes were measured for one plant per treatment at 4 and 8 WAT. Shoots were clipped at the soil surface and placed in paper bags, and fresh weights were recorded. Soil was washed from roots and fresh root weight, including rhizomes, was recorded. Rhizomes were then removed, weighed and measured for total length, and placed into paper bags. Shoots, roots, and rhizomes were oven-dried at 66 C for a minimum of 72 h, after which dry weights were recorded.

Data were analyzed as a two-factor factorial using Proc Mixed in SAS[6] where factors were rates of asulam and trifloxysulfuron. Replications nested within experimental runs and their interactions with the number of weeks after treatment were treated as random effects; all other variables were treated as fixed. Means were separated by the Proc Mixed lsmeans macro as described by Saxton (1998). For whole-plant biomass, Colby's (1967) method for calculating synergistic, additive, and antagonistic effects for herbicide mixtures was used for comparing observed and expected responses to combinations of asulam and trifloxysulfuron. Expected johnsongrass biomass was determined by

$$E = XY/Z$$

where $E$ = expected johnsongrass biomass, X = johnsongrass biomass with trifloxysulfuron, $Y$ = johnsongrass biomass with asulam, and Z = johnsongrass biomass with no herbicide application. If actual johnsongrass biomass was less than (according to Fisher's LSD at $P > 0.05$) the expected biomass for combinations of asulam and trifloxysulfuron, the response was deemed to be synergistic. If actual biomass was greater than the expected biomass, the response was deemed antagonistic. If the actual biomass was similar to the expected biomass, the response was deemed additive (Hamill and Penner 1973).

**Field Study.** To determine johnsongrass control and sugarcane tolerance to combinations of asulam and trifloxysulfuron, field studies were conducted at the USDA-ARS Ardoyne Research Farm in 2005 and 2006 on a Cancienne silty clay loam (fine-silty, mixed, superactive, nonacid, hyperthermic Fluvaquentic Epiaquepts). Additionally, a new formulation of asulam[7] was compared with a commercially available formulation.[1] Sugarcane was managed by conventional practices. Johnsongrass seedlings were not controlled after planting to allow for establishment of rhizome johnsongrass. Sugarcane was fertilized in late March of each year by injecting 112 kg/ha N, 15 kg/ha P, and 56 kg/ha K approximately 15 cm deep on both sides of the planted sugarcane row.

Both formulations of asulam were applied at 1,800, 2,800, and 3,700 g/ha with and without trifloxysulfuron at 16 g/ha. All herbicide treatments were applied with a non-ionic surfactant[4] at 0.25% (v/v). A nontreated control was included for comparison. Treatments were broadcast-applied with a tractor-mounted sprayer equipped with 8002 flat fan nozzles[5] at a volume of 187 L/ha with the use of compressed air (221 kPa) as the propellant. Plots consisted of three rows of sugarcane and were 5 m wide by 9 m long. Treatments were arranged in a randomized complete block design with four replications.

In 2005, treatments were applied on April 15 to a plant cane crop of LCP 85-384 sugarcane having four leaves and measuring 6 cm from the soil surface to the uppermost visible leaf collar and to johnsongrass measuring 10 cm to the uppermost visible leaf collar. In 2006, treatments were applied on April 5 to a first ratoon crop of LCP 85-384 sugarcane having four leaves measuring 8.7 cm and to johnsongrass measuring 19 cm.

Sugarcane injury and johnsongrass control were visually rated on a scale of 0 (no injury/control) to 100 (complete injury/control) relative to the nontreated check at 5, 8, and 10 WAT. Sugarcane was harvested on October 31, 2005, and October 25, 2006, with a commercial sugarcane chopper harvester.[8] Plot weights were determined with the use of a wagon equipped with electronic load cells and were used to calculate gross cane yields. Sample pieces of stalk (billets) from each plot were collected with a sampler built into the wagon that allowed for random collection of billets as they dropped from the harvester's elevator.

Billet samples were analyzed for sucrose content and quality by the core/press method (Legendre 1992). Billets were passed through a chipper to create a homogeneous mixture. A 1,000-g sample of the chipped billets was collected and placed into a hydraulic press for 2 min at 21 MPa to extract juice. Extracted juice was analyzed for percent by weight of soluble

Table 1. Effect of asulam and trifloxysulfuron on plant height and length of rhizomes for johnsongrass grown in containers. Results represent the average of two experiments.[a,b]

| Treatment[c] | | Johnsongrass height | | | Rhizome length | |
|---|---|---|---|---|---|---|
| Asulam | Trifloxysulfuron | 2 WAT | 4 WAT | 8 WAT | 4 WAT | 8 WAT |
| g/ha | | cm | | | | |
| 0 | 0 | 83 a | 117 a | 133 a | 48 a | 113 a |
| 0 | 8 | 68 b | 71 c | 96 b | 16 b | 59 b |
| 460 | 0 | 76 ab | 86 b | 102 b | 35 ab | 45 bc |
| 460 | 8 | 71 b | 69 c | 84 bc | 24 ab | 15 de |
| 920 | 0 | 82 a | 90 b | 102 b | 36 ab | 28 cde |
| 920 | 8 | 69 b | 66 c | 58 c | 13 b | 4 e |

[a] Abbreviations: WAT, weeks after treatment.

[b] Means within columns followed by the same lowercase letter are not significantly different by the *F* test and the PROC MIXED lsmeans macro described by Saxton (1998) at alpha = 0.05.

[c] A non-ionic surfactant (0.25% v/v) was added to all herbicide treatments.

Table 2. Effect of asulam and trifloxysulfuron on biomass of johnsongrass grown in containers. Results represent the average of two experiments.[a,b]

| Treatment[c] | | Shoot biomass | | Root biomass | | Whole-plant biomass[d] | |
|---|---|---|---|---|---|---|---|
| Asulam | Trifloxy-sulfuron | 4 WAT[b] | 8 WAT | 4 WAT | 8 WAT | 4 WAT | 8 WAT |
| g/ha | | g | | | | | |
| 0 | 0 | 42 a | 73 a | 22 a | 40 a | 64 a | 112 a |
| 0 | 8 | 37 ab | 62 ab | 14 ab | 30 b | 50 ab | 92 b |
| 460 | 0 | 31 bc | 56 b | 12 b | 27 b | 43 b | 82 b |
| 460 | 8 | 27 bc | 35 c | 8 b | 13 c | (33) 35 b | (67) 48 c |
| 920 | 0 | 30 bc | 35 c | 11 b | 13 c | 40 b | 48 c |
| 920 | 8 | 25 c | 17 d | 10 b | 5 c | (31) 34 b | (39) 22 d |

[a] Abbreviations: WAT, weeks after treatment.

[b] Means within columns followed by the same lowercase letter are not significantly different by the *F* test and the PROC MIXED lsmeans macro described by Saxton (1998) at alpha = 0.05.

[c] A non-ionic surfactant (0.25% v/v) was added to all herbicide treatments.

[d] Numbers in parentheses are predicted values for expected responses according to the equation derived by Colby (1967) for calculating synergistic responses to herbicides.

solids (Brix) and percent apparent sucrose by weight (pol) with a refractometer[9] and saccharimeter,[10] respectively. The remaining stalk fibers (filter cake) were weighed wet, placed into paper bags, and dried in a forced-air oven at 66 C for a minimum of 72 h, after which, dry weights were recorded. Theoretically recoverable sugar (TRS, kg sugar/Mg harvested cane) was calculated from these analyses and measurements according to standard methodologies (Legendre 1992; Legendre and Henderson 1972). Theoretical sugar yield (kg/ha) was determined as the product of TRS (kg/Mg) and gross cane yield (Mg/ha).

Data were analyzed as a two-factor factorial by Proc Mixed in SAS,[6] wherein factors were the rates of asulam and trifloxysulfuron. Replication nested within year was treated as a random factor. Arcsine square root–transformed data were used; data from the nontreated control were excluded for analysis of weed control and sugarcane injury, but untransformed data are presented for clarity. Means were separated by the Proc Mixed lsmeans macro as described by Saxton (1998).

## Results and Discussion

**Container Study.** When averaged across experiments, johnsongrass height increased from 83 cm 2 WAT to 133 cm 8 WAT when no herbicide was applied (Table 1). The effects of trifloxysulfuron on johnsongrass were observed sooner after application compared with asulam. For example, at 2 WAT, trifloxysulfuron applied alone or in combination with asulam, reduced johnsongrass height compared with the nontreated control, whereas asulam did not. At 4 WAT, johnsongrass height was reduced for all herbicide treatments compared with the nontreated control. Treatments containing trifloxysulfuron reduced johnsongrass height by an average of 22% compared with asulam applied alone. Where trifloxysulfuron was applied alone, johnsongrass height increased by 25 cm between 4 and 8 WAT as plants recovered from the initial herbicide injury. Johnsongrass height also increased 20 to 26 cm between 2 and 8 WAT where asulam was applied alone. However, combinations of trifloxysulfuron and asulam suppressed johnsongrass growth for the full 8 wk of the study (Table 1).

The length of johnsongrass rhizomes 4 WAT decreased from 48 cm/plant in the nontreated control to 16 or 13 cm where trifloxysulfuron was applied alone or with 920 g/ha of asulam, respectively (Table 1). The remaining herbicide treatments did not reduce rhizome length 4 WAT compared with the nontreated control, but all treatments reduced rhizome length 8 WAT. The greatest reduction in rhizome length occurred from combinations of asulam and trifloxysulfuron or when asulam was applied alone at 920 g/ha. Trifloxysulfuron applied with 920 g/ha of asulam reduced rhizome length by 96% compared with the nontreated control (Table 1). Use of herbicides that reduce rhizome growth is very important in sugarcane production because the effect of johnsongrass on subsequent ratoon crops would be greatly reduced.

Trifloxysulfuron applied alone did not reduce root, shoot, or whole-plant biomass 4 WAT or shoot biomass 8 WAT (Table 2). However, it reduced root and whole-plant biomass 8 WAT by 25 and 18%, respectively, compared with the nontreated control. All rates of asulam reduced shoot, root, and whole-plant biomass 4 and 8 WAT. Most combinations of asulam and trifloxysulfuron reduced shoot, root, and whole-plant biomass 8 WAT to a greater extent than asulam applied alone.

Calculations were made to determine whether combinations of asulam and trifloxysulfuron were additive or synergistic with regard to johnsongrass control according to a derivation of the equation described by Colby (1967). The expected biomass of johnsongrass treated with asulam and trifloxysulfuron was 67 and 39 g/plant for asulam rates of 460 and 920 g/ha, respectively, whereas the observed biomass was 48 and 22 g/plant, respectively. Because the observed biomass was significantly less than the expected biomass (Fisher's LSD = 16 g/plant at P = 0.05), the combination of asulam and trifloxysulfuron was synergistic on johnsongrass.

Combinations of asulam and trifloxysulfuron reduced biomass 8 WAT to a greater extent than either herbicide applied alone, but this was not observed for biomass 4 WAT.

Table 3. Effect of asulam and trifloxysulfuron on johnsongrass control and sugarcane yield. Results represent the average of two field experiments conducted in 2005 and 2006.[a,b]

| Treatment[c] | | Johnsongrass control | | | Sugar yield |
|---|---|---|---|---|---|
| Asulam | Trifloxysulfuron | 5 WAT | 8 WAT | 10 WAT | |
| g/ha | | % | | | kg/ha |
| 0 | 0 | 0 | 0 | 0 | 2,080 e |
| 0 | 16 | 42 e | 29 e | 19 e | 2,960 e |
| 1,800 | 0 | 63 d | 40 d | 33 d | 4,820 d |
| 1,800 | 16 | 70 c | 62 ab | 48 bc | 5,660 c |
| 2,800 | 0 | 70 c | 49 c | 45 c | 5,800 bc |
| 2,800 | 16 | 75 b | 68 a | 59 a | 6,510 ab |
| 3,700 | 0 | 73 bc | 55 bc | 53 ab | 6,140 abc |
| 3,700 | 16 | 79 a | 69 a | 56 a | 6,680 a |

[a] Abbreviations: WAT, weeks after treatment.

[b] Means within a column followed by the same letter are not significantly different by the *F* test and the PROC MIXED lsmeans macro described by Saxton (1998) at alpha = 0.05.

[c] A non-ionic surfactant (0.25 % v/v) was added to all herbicide treatments.

This result might be partially explained by the slow activity of asulam (Bruff et al. 1995; Millhollon 1976; Richard 1986, 1990). At 4 WAT, the effects of asulam on johnsongrass were incomplete. Trifloxysulfuron is faster acting compared with asulam but does not adequately control rhizome johnsongrass when applied alone. Johnsongrass height at 2 WAT was reduced by trifloxysulfuron but not by asulam. These two herbicides affect johnsongrass plants at different metabolic sites. Asulam inhibits DHP synthesis (Stephen et al. 1980; Veerasekaran et al. 1981a,b), and trifloxysulfuron inhibits branched-chain amino acid synthesis (LaRossa and Schloss 1984; Ray 1984). The synergism in activity on johnsongrass between these herbicides and their sites of action when applied in combination appeared to result in more effective control compared with application of either alone. The combination of asulam and trifloxysulfuron was equally effective at reducing root, shoot, and rhizome growth.

**Field Study.** When comparing asulam formulations, weed control and sugarcane injury did not differ, so data were combined across formulations (data not shown). Furthermore, weed control and sugarcane response to herbicide applications did not differ between years, so data were combined over years.

Herbicides caused less than 10% injury to sugarcane at all evaluation timings. Injury was manifested as a yellow band on sugarcane leaves that had been in the whorl at the time of application (data not shown). Trifloxysulfuron at 16 g/ha controlled johnsongrass 42% 5 WAT, but control 8 and 10 WAT decreased to 29 and 19%, respectively (Table 3). Combining trifloxysulfuron with 1,800, 2,800, or 3,700 g/ha of asulam generally increased johnsongrass control compared with asulam alone. For example, asulam applied alone at 1,800, 2,800, and 3,700 g/ha controlled 63, 70, and 73%, respectively, of johnsongrass 5 WAT but this increased to 70, 75, and 79%, respectively, when combined with trifloxysulfuron. The combination of trifloxysulfuron and 1,800 g/ha asulam resulted in control similar to asulam applied alone at 3,700 g/ha at all evaluation timings (Table 3). These results support those of previous research in which asulam, applied at 50% of the recommended rate, combined with trifloxysulfuron resulted in control similar to the recommended rate of asulam applied alone (Jones et al. 2002). However, results of this research showed that johnsongrass control increased further when trifloxysulfuron was applied with 3,700 g/ha asulam compared with 1,800 g/ha asulam (Table 3).

Application of trifloxysulfuron alone did not affect sugar yield compared with the nontreated control (Table 3). In contrast, sugar yield for the lowest rate of asulam (1,800 g/ha) was twice that of the nontreated control. Sugar yield increased with asulam rate, up to the rate of 2,800 g/ha. Combinations of asulam and trifloxysulfuron resulted in increased sugar yield compared with asulam alone only when asulam was applied at 1,800 g/ha (Table 3). Because of the lack of an interaction between asulam and trifloxysulfuron for sugar yield, data for each herbicide were averaged across all rates of the other. Application of trifloxysulfuron increased sugar yields by 12%, averaged over asulam rates (data not shown).

The results of this study show the benefit of controlling johnsongrass in sugarcane. Johnsongrass reduced sugarcane yield by up to 69% in the nontreated control. Combinations of trifloxysulfuron and asulam improved control of rhizome johnsongrass in sugarcane and resulted in higher sugar yields compared with either herbicide applied alone. Combining these herbicides also resulted in greater inhibition of johnsongrass rhizome production.

The highest rate of asulam applied alone or in combination with trifloxysulfuron did not completely control johnsongrass in any of these studies but did suppress growth long enough that sugarcane was able to gain a competitive advantage. Failure to control rhizome johnsongrass might result in extreme yield losses that could force growers to destroy ratoons prematurely to rehabilitate fields. This would necessitate replanting the fields before reaping a sufficient number of ratoon crops to gain the maximum return on investment required for planting a sugarcane crop, which currently is estimated to cost \$3,000 to \$3,150/ha, including fallow field and seedbed preparation costs (Salassi and Deliberto 2008).

The addition of 16 g/ha trifloxysulfuron to asulam treatments in a broadcast application would increase herbicide costs by \$50/ha at current prices (R. Boudreaux, personal communication). Some of this increased cost could be offset by reducing the rate of asulam to less than 3,700 g/ha, which currently costs \$78/ha when applied broadcast (R. Boudreaux, personal communication). In this study, the combination of 1,800 g/ha asulam and 16 g/ha trifloxysulfuron resulted in sugar yield similar to that of asulam applied alone at 3,700 g/ha. Application of the combination at these rates would increase herbicide costs by \$11/ha compared with asulam applied alone at the higher rate. However, results of this study also show sugar yield was maximized where asulam was applied at a rate of at least 2,800 g/ha (Table 3). When current herbicide prices and market rates for sugar (\$0.506/kg) are taken into consideration, reducing the asulam rate in combinations with trifloxysulfuron from 2,800 and 3,700 g/ha to 1,800 g/ha would result in an economic loss of \$430 to \$516/ha (Salassi and Deliberto 2008).

Maximum effectiveness of asulam has previously been shown to require a rain-free period of up to 48 h after application (Bruff et al. 1995). Because rain soon after application was not a factor in our studies, we could not determine whether the addition of trifloxysulfuron would shorten the rain-free period for control of johnsongrass with asulam. It is also unknown whether the combination of trifloxysulfuron and asulam would reduce rhizome production under field conditions compared with asulam alone, although this occurred under greenhouse conditions. A reduction in rhizome production could lengthen the productivity of a sugarcane field by allowing a greater number of ratoon harvests before fallowing and replanting.

## Sources of Materials

[1] Asulox, Bayer CropScience LP, P.O. Box 12014, Research Triangle Park, NC 27709.

[2] Envoke, Syngenta Crop Protection Inc., P.O. Box 18300, Greensboro, NC 27419.

[3] Redi-earth Plug & Seedling Mix, Sun Gro Horticulture, 15831 NE 8th Street, Suite 100, Bellevue, WA 98008.

[4] LI 700®, Loveland Products Inc., 7251 W 4th Street, Greeley, CO 80634.

[5] Teejet 8002XR nozzle, Spraying Systems Company, P.O. Box 7900, Wheaton, IL 60189.

[6] SAS Version 9.1, SAS Institute Inc., 100 SAS Campus Drive, Cary, NC 27513-2414.

[7] Asulox XP, Bayer CropScience LP, P.O. Box 12014, Research Triangle Park, NC 27709.

[8] CAMECO® 3500 Chopper Harvester, John Deere Thibodaux Inc., 244 Highway 3266, Thibodaux, LA 70301-1602.

[9] RFM 190 Refractometer, Bellingham and Stanley Ltd., Longfield Road, North Farm Industrial Estate, Tunbridge Wells, Kent, United Kingdom.

[10] Autopol 880 automated saccharimeter, Rudolph Research Analytical, 55 Newburgh Road, Hackettstown, NJ 07840.

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## Literature Cited

Anonymous. 1983. Weed survey—southern states. South. Weed Sci. Soc. Res. Rep. 36:148–184.

Anonymous. 2008. Louisiana's Suggested Chemical Weed Control Guide for 2008. Baton Rouge, LA: Louisiana State University Agriculture Center, Louisiana Cooperative Extension Service Publ, 1565. http://www.lsuagcenter.com. Accessed February 22, 2008.

Brecke, B. J. and D. O. Stephenson. 2006. Weed control in cotton (*Gossypium hirsutum*) with postemergence applications of trifloxysulfuron-sodium. Weed Technol. 20:377–383.

Bruff, S. A., J. L. Griffin, and E. P. Richard Jr. 1995. Influence of rainfree period after asulam application on johnsongrass (*Sorghum halepense*) control. Weed Technol. 9:316–320.

Colby, S. R. 1967. Calculating synergistic and antagonistic responses of herbicide combinations. Weeds. 15:20–22.

Grichar, W. J. and B. W. Minton. 2007. Using trifloxysulfuron with glyphosate for cotton weed control. Weed Technol. 21:431–436.

Hamill, A. S. and D. Penner. 1973. Interaction of alachlor and carbofuran. Weed Sci. 21:330–335.

Jones, C. A., J. L. Griffin, and J. D. Siebert. 2002. Alternatives for johnsongrass control in sugarcane. Proc. South. Weed Sci. Soc. 55:21.

LaRossa, R. A. and J. V. Schloss. 1984. The herbicide sulfometuron methyl is bacteriostatic due to inhibition of acetolactate synthase. J. Biol. Chem. 259:8753–8757.

Legendre, B. L. 1992. The core/press method of predicting the sugar yield from cane for use in payment. Sugar J. 54:2–7.

Legendre, B. L. and M. T. Henderson. 1972. The history and development of sugar yield calculations. Proc. Am. Soc. Sugarcane Technol. 2(NS):10–18.

Lencse, R. J., J. L. Griffin, and E. P. Richard Jr. 1992. Itchgrass (*Rottboellia cochinchinensis*) control in sugarcane with postemergence herbicides. J. Am. Soc. Sugar Cane Technol. 12:9–15.

Millhollon, R. W. 1976. Asulam for johnsongrass control in sugarcane. Weed Sci. 24:496–499.

Millhollon, R. W. 1993. Preemergence control of itchgrass (*Rottboellia cochinchinensis*) and johnsongrass (*Sorghum halepense*) in sugarcane (*Saccharum* spp hybrids) with pendimethalin and prodiamine. Weed Sci. 41:621–626.

Porterfield, D., J. W. Wilcut, and S. D. Askew. 2002. Weed management with CGA-362622, fluometuron, and prometryn in cotton. Weed Sci. 50:642–647.

Rawls, E. K., J. W. Wells, M. Hudetz, R. Jain, and M. F. Ulloa. 2000. CGA-362622: a new herbicide for weed control in sugarcane. Proc. South. Weed Sci. Soc. 53:163.

Ray, T. B. 1984. Inhibition of valine and isoleucine biosynthesis in plants. Plant Physiol. 75:827–831.

Richard, E. P., Jr 1986. Influence of surfactants on the toxicity of asulam to johnsongrass (*Sorghum halepense*) and sugarcane (*Saccharum*sp.). Weed Sci. 34:299–303.

Richard, E. P., Jr 1990. Timing effects on johnsongrass (*Sorghum halepense*) control with asulam in sugarcane (*Saccharum* sp.). Weed Technol. 4:81–86.

Richard, E. P., Jr 2000. Evaluation of CGA 362622 in Louisiana sugarcane. Proc. South. Weed Sci. Soc. 53:14.

Richard, E. P., Jr and J. L. Griffin. 1993. Johnsongrass (*Sorghum halepense*) control in sugarcane with selected preemergence and postemergence herbicides. J. Am. Soc. Sugar Cane Technol. 13:60–72.

Richardson, R. J., H. P. Wilson, G. R. Armel, and T. E. Hines. 2004. Mixtures of glyphosate with CGA 362622 for weed control in glyphosate-resistant cotton (*Gossypium hirsutum*). Weed Technol. 18:16–22.

Salassi, M. E. and M. Deliberto. 2008. Sugarcane Production in Louisiana: 2008 Projected Commodity Costs and Returns. A.E.A. Information Services 245. Louisiana State University Agriculture Center. 41 p www.lsuagcenter.edu.

Saxton, A. M. 1998. A macro for converting mean separation output to letter groupings in Proc Mixed. Pp. 1243–1246 *in* Proceedings of the 23rd SAS Users Group International, March 1999. Nashville, TN, Cary, NC: SAS Institute.

Singh, S. and M. Singh. 2004. Effect of growth stage on trifloxysulfuron and glyphosate efficacy in twelve weed species of citrus groves. Weed Technol. 18:1031–1036.

Stephen, N. H., G. T. Cook, and H. J. Duncan. 1980. A possible mechanism of action of asulam involving folic acid biosynthesis. Ann. App. Biol. 96:227–234.

Teuton, T. C., J. B. Unruh, B. J. Brecke, G. E. MacDonald, G. L. Miller, and J. T. Ducar. 2004. Tropical signalgrass (*Urochloa subquadripara*) control with preemergence- and postemergence-applied herbicides. Weed Technol. 18:419–425.

Veerasekaran, P., R. C. Kerkwood, and E. W. Parnell. 1981a. Studies of the mechanism of action of asulam in plants. Part I: antagonistic interaction of asulam and 4-amino-benzoic acid. Pestic. Sci. 12:325–329.

Veerasekaran, P., R. C. Kerkwood, and E. W. Parnell. 1981b. Studies of the mechanism of action of asulam in plants. Part II: effect of asulam on the biosynthesis of folic acid. Pestic. Sci. 12:330–338.

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